PROTOTYPE FLEXIBLE CABLES FOR D0 SILICON READOUT

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Overview

An upgrade for the silicon detector system for the D0 experiment at Fermilab is now in the production stage. This upgrade will require approximately 144 flex circuit cables of up to about 60 cm in length to carry signals and power. The production flex cables will be operated at around 0 degrees C with normal pressure and humidity, but in a high radiation environment with an expected total exposure as large as several tens of Megarads.

The cable design will be built in 4 lengths. All cables have the same layout of traces and the same thickness of dielectric; they differ only in the total length. This RFQ addresses quotes for prototype cables and for production cables.

Preliminary layouts of the flex cables are provided in the attached Word and Excel files. A CAD layout is available in several formats, including Eagle and Gerber formats.

The cables have 1 oz copper signal and power traces on both sides of a Kapton dielectric of 4 mil total thickness (including adhesive layers). The standard signal trace width over most of the cable is 0.125 mm (4.9 mils). The smallest gap between traces is 0.150 mm (5.9 mils). One isolated trace will be run at up to 1000 V. Approximately 100 vias are required near the cable ends. The smallest via pads are ovals 0.8 mm x 1.6 mm, with vias separated by 0.8 mm. Two to four vias are used on each pad for redundancy. At each end of the cable are 46 gold-plated pads of pitch 0.5 mm for attachment of a miniature connector. Both sides of the cable will have a 1 to 2 mil cover layers; the cover layers over the gold pads will later be removed by laser ablation by another vendor.

The double-sided copper Kapton materials are to be provided by the University of Kansas.

Scope and Schedule of Ordering

We would like a quote for a single run of 36 cables of each of the four lengths (~52cm, ~53cm, ~55cm, and ~57 cm) for a total of 144 cables.

Desired completion date: ASAP or sooner. Speed is an issue in this order. We have a very tight deadline and would like the time to completion included on the quote.

Specifications

Lengths: 36 @ ~52 cm, 36 @ ~53 cm, 36 @ ~55 cm, and 36 @ ~57 cm.

Dielectric: Kapton without fire retardant (e.g. Rogers R/flex 2001) 2.0 mils thick with 1.0 mil adhesive on each side, for a total of 4.0 mil dielectric thickness.

Thickness of copper: Standard 1 oz (0.65 mil nominal thickness).

Cover layers: Kapton cover layers top and bottom, each 1-2 mils thick including adhesive. The cover over the high-voltage trace must hold off 1000 V.

Width of signal traces: The nominal width of long traces is 0.125 mm (4.9 mils). For controlled impedance, the average width of each trace should be within ±15% of this value. Local variations in width along the length of a given line can be larger, ~±25%. A simple measurement of the DC resistance of each line will be a sufficiently good measure of its average width.

Voltage holdoffs and accidental shorts: The broad power traces will carry currents of up to 0.3 A at 2.5 V. The single high-voltage line, which is separated by ~1 mm from the others, will be run at up to 1000 V. Shorts or arcing between lines or layers, or to neighboring grounded objects, must not occur.

Registration of layers: Transverse registration of the top and bottom copper layers over the full length should be maintained to ±7 mils or better. Registration near the ends should be sufficient to allow reliable placement of vias.

Diameter of plated-through holes: A drill diameter of 8 to 12 mils is acceptable if consistent with the pad size (1.6 mm x 0.8 mm oval).

Resistance of plated-through holes: Resistance of the plated-through holes between top and bottom layers should contribute no more than an additional 0.025 ohms to the resistance of each trace. Note that 2-4 plated-through holes are used at each end of these traces to lower this resistance. A solid fill of the plated-through holes is acceptable and may be preferred.

Trimming: The flex cable is to be cut into a strip not exceeding 14.7 mm. The nominal gap between the outer edge of the dielectric and the nearest copper is 0.65 mm. It is desirable to maintain this gap as 0.65 mm (+0.0 –0.2) mm on the edge near the high-voltage trace, and as 0.65 mm (+0.0 –0.3 mm) on the other edge.

Connector pads

Subminiature 50-pin connectors will be installed on both ends by soldering to gold-plated pads on the flex The parts to be used are from the Molex 55560 and 54722 families. The manufacturer's specs on these pads are given below. Extensions of the pads beyond the gold-plated area are captured under the coverlay to help hold the pads down.

Pitch of connector pads: 0.50±0.05 mm (error is non-cumulative)

Width of connector pads: 0.30±0.05 mm

Length of gold-plated region: 2.9±0.1 mm

Testing by vendor

Visual inspection will be performed by the vendor over the full length of each line with a magnification sufficient to find serious defects and variations in trace width.

After installation of connectors, each cable will be tested by the D0 group for shorts and opens, line resistance and impedance, and high-voltage holdoff.

Notes

1. Since minimum-order quantities of copper-clad Kapton material may be an issue, we request quotes with the University of Kansas supplying the raw materials. The vendor will supply the coverlay and adhesive materials.

2. Quotes should not include installation of connectors or removal of cover layer over connector pads.